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THE WORK OF THE YUMA RECLAMATION PROJECT EXPERIMENT FARM IN 1913.[1]

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INTRODUCTION.

The Colorado River Valley lands included in the Yuma Reclamation Project lie in a region of such unusual climatic conditions that their future development depends largely on the culture of specialized crops. The conditions are particularly favorable to such crops as cotton, alfalfa, alfalfa seed, figs, dates, sweet potatoes, and other crops which require a warm climate and which are well suited to intensive culture. The work of the Yuma Experiment Farm is concerned chiefly with these crops.

Most of the experiments conducted during the seasons of 1911 and 1912 have been continued, and several others were inaugurated in 1913. Variety tests of fruits have been conducted, various strains and varieties of field crops and vegetables have been tested, and different cultural methods for the various crops have been tried. The arrangement of the fields and the location of the experiments in 1913 are shown in figure 1. The chief features of the progress made in 1913 are reported in this paper.

COOPERATIVE WORK.

Other offices of the Bureau of Plant Industry have cooperated in carrying on certain of the experiments. The Office of Acclimatization and Adaptation of Crop Plants cooperates in the breeding and cultural experiments with cotton and in the work of acclimatizing

[1] The Yuma Experiment Farm is located on the Yuma Reclamation Project, 7 miles north of Yuma, Ariz., and adjacent to Bard, Cal. It consists of 160 acres of land, all of which is irrigable. The land was withdrawn from entry in 1909 by the Department of the Interior, to be used as an experiment farm. Operations on the farm were begun in the spring of 1910. A farmhouse and an office building were constructed by the United States Reclamation Service; a tool house and a machine shed have been built by the United States Department of Agriculture. The farm is under the direct supervision of a superintendent detailed from the Office of Western Irrigation Agriculture, Bureau of Plant Industry, and that office furnishes the funds necessary to maintain the farm.

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and breeding Palestine wheat. The Office of Crop Physiology and Breeding Investigations cooperates in variety and breeding tests of figs, dates, and pistache nuts. The Office of Foreign Seed and Plant Introduction does cooperative work in connection with various fruit varieties, nursery stock, and ornamentals. The Office of Alkali and Drought Resistant Plant Investigations cooperates in variety tests of

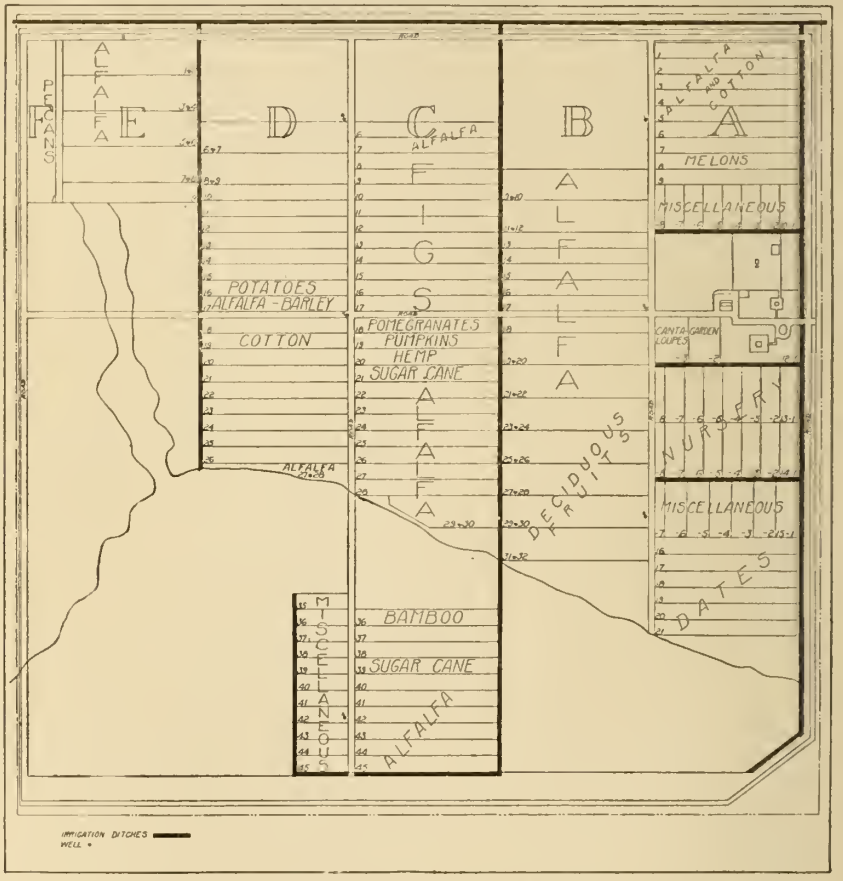

FIG. 1.—Diagram of the Yuma Experiment Farm, showing the arrangement of the fields and the location of the experiments in 1913.

pomegranates, and the meteorological observations are made in cooperation with the Biophysical Laboratory. Some cooperation is had with several other offices of the Bureau of Plant Industry in minor lines of work.

FARM BUILDINGS AND IMPROVEMENTS.

On the north line of the experiment farm 160 rods of fence were constructed during the year. In cooperation with the neighboring ranchers adjoining on the north, a 40-foot road was leveled and put

in shape for irrigating. Through cooperation with the Reclamation Service a test of the action of alkali on various concrete mixtures for various periods of time was inaugurated by placing a 500-foot lateral of concrete draintile beneath a strongly alkaline field. This test will extend over a period of 10 years. A test meter for accurately measuring the flow of water in an open ditch has been installed on one of the farm laterals for the purpose of making various water measurements.

CONDITIONS ON THE PROJECT.

CLIMATIC CONDITIONS.

Weather conditions during the year 1913 were generally favorable to crop growth. No severe storms of any nature occurred. Some damage resulted from wind and sand storms, which in March cut off young alfalfa plants in early spring plantings on loose soils. The growing season opened rather late, and cold nights through April and early May retarded the growth of the cotton to some extent.

Table I briefly summarizes the climatological observations recorded at the experiment farm during 1913, together with the weather conditions recorded in the 4-year period during which observations have been made.

TABLE I.—*Summary of climatological observations at the Yuma Experiment Farm, 1910 to 1913, inclusive.*

PRECIPITATION (INCHES).[1]

Item.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Average for 4 years, 1910 to 1913	0.17	0.38	0.36	0.18	0.19	0.13	0.30	0.23	0.14	0.26	0.29	0.002	2.532
For 1913	.03	.36	.00	.19	.00	.00	.09	.88	.00	.00	.37	.00	1.92

EVAPORATION (INCHES).[2]

Average for 4 years, 1910 to 1913	3.41	4.29	6.85	6.74	10.15	10.7	10	9.7	8.18	6.14	4.10	3.15	83.44
For 1913	3.51	3.71	6.61	7.22	8.22	9.05	9.13	7.87	7.90	5.13	3.03	2.37	73.78

DAILY WIND VELOCITY (MILES PER HOUR).[3]

Highest.													
1910					9.0	8.8	7.4	7.2	4.6	9.2	6.3	6.1	
1911	7.4	8.5	5.4	9.2	8.1	6.3	6.0	3.2	4.1	6.7	10.7	9.9	
1912	5.4	7.4	9.3	8.3	6.9	4.4	5.1	5.9	4.7	7.9	11.4	10.8	
1913	11.7	8.3	9.6	6.8	6.3	7.0	4.3	4.4	5.6	7.5	5.1	3.5	
Lowest.													
1910					2.3	1.1	1.5	2.0	1.2	.8	1.7	1.8	
1911	.8	.8	1.3	1.5	1.8	1.4	1.3	0	1.1	.8	1.0	1.3	
1912	1.5	1.1	1.1	1.7	1.5	1.0	1.5	1.2	.3	1.2	1.3	.8	
1913	1.7	1.3	1.3	1.0	.8	1.1	.8	.8	.8	.5	.4	1.0	
Average:													
1910					4.1	3.8	3.6	3.4	2.4	3.7	3.3	3.5	
1911	3.0	3.5	2.7	3.8	3.3	2.9	2.5	2.0	1.7	2.5	3.7	3.5	
1912	3.2	4.0	3.9	3.8	3.3	2.6	2.3	2.3	2.1	3.0	2.9	4.0	
1913	3.7	3.3	4.1	3.1	2.4	2.1	2.1	2.1	2.0	1.9	1.8	2.1	

[1] Records of precipitation date from July 1, 1910.
[2] Records of evaporation date from Apr. 21, 1910.
[3] Records of wind velocity date from May 9, 1910.

TABLE 1.- *Summary of climatological observations at the Yuma Experiment Farm, 1910 to 1913, inclusive*—Continued.

MONTHLY TEMPERATURE (°F.).[1]

Item.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Absolute maximum:													
4 years, 1910 to 1913	84	88	94	106.5	120	117	116	113	116	107	94	81	120
For 1913	78	81	92	98	101	108	115	109	113	96	90	75	115
Absolute minimum:													
4 years, 1910 to 1913	16	27	37.5	32	35	47	55	57	48	36	28	16	16
For 1913	16	27	30	37	42	50	55	57	48	36	37	24	16
Mean:													
4 years, 1910 to 1913	52.5	54.6	60.4	68.2	73.7	80.7	87.6	88.5	82.5	69.9	60.6	51.2	69.2
For 1913	47.9	54.6	57.1	66	74	78.1	86.3	89.1	83.3	69	62.3	51.7	78.3

KILLING FROSTS.

Year.	Last in spring.		First in autumn.		Frost-free period.
	Date.	Minimum temperature.	Date.	Minimum temperature.	
		° *F.*		° *F.*	*Days.*
1910			Nov. 27	32	
1911	Feb. 24	32	Nov. 24	32	262
1912	Mar. 31	32	Dec. 4	31	247
1913	Mar. 28	32	Dec. 2	31	248

[1] Records of maximum and minimum temperatures date from Apr. 21, 1910.

CROP CONDITIONS.

Compared with the results of previous years, crop yields during the season of 1913 were high for the entire project. The Colorado River was not excessively high at any period, and the areas damaged by seepage and a high water table were small. Toward the close of the season these areas were benefited by the construction of an open drainage ditch by the Reclamation Service.

In 1913 there were 616 farms on the project, with a total irrigable area of 32,732 acres. An area of 19,607 acres was actually irrigated. Of this, an area of 2,881 acres was devoted to orchards not yet in bearing and to other crops not harvested, so that the area from which crops were harvested amounted to 16,726 acres. This harvested area was larger by 5,666 acres than in 1912. The total farm value of all crops on the project was $610,228 in 1913, as compared with $497,012 in 1912. The average farm value per acre in 1913 was $36.48, as compared with $44.94 a year ago. The acreage, yields, and farm values of the crops grown on the project in 1913 are shown in Table II, the figures being obtained from the Reclamation Service.

TABLE 11.—*Acreage, yields, and farm values of the crops grown on the Yuma Reclamation Project in 1913.*

Crop.	Area.	Unit of yield.	Yield.			Farm value.			
			Total.	Per acre.		Per unit of yield.	Total.	Per acre.	
				Average.	Maximum.			Average.	Maximum.
	Acres.								
Alfalfa hay	10,321	Ton	38,100	3.69	10	$7.53	$287,195	$27.83	$75.30
Alfalfa straw and winter pasture.	10,321						30,963	3.00	
Other hay	985	Ton	1,485	1.50	2.25	8.96	13,309	13.52	20.16
Alfalfa seed	3,388	Pound	1,139,100	336	900	.111	126,450	37.33	99.90
Barley	1,201	Bushel	37,370	31	70	.628	23,475	19.55	43.96
Beans	54	do	395	7.3	30	2	790	14.63	60.00
Corn	289	do	3,752	13	50	.735	2,759	9.55	36.75
Milo	2,928	do	112,597	38.5	100	.513	57,740	19.72	51.30
Cane and corn fodder	598	Ton	1,709	2.86	5	3.733	6,380	10.66	18.66
Truck	264						22,000	83.34	
Fruit	47						5,623	119.62	
Cotton	62	Pound	19,610	316	625	.21	4,123	66.70	131.25
Pasture	1,007						22,765	22.61	
Wheat	384	Bushel	7,705	20.1	50	.864	6,656	17.32	43.20
Less duplications	15,123								
Total	16,726						610,228		
Value per acre								36.48	

CROP EXPERIMENTS.

GREEN MANURES.

The experiment farm is located on land having a soil which is fairly representative of the Yuma project. The soil is chiefly a fine sandy loam underlain directly by a subsoil of medium-fine sand. Originally, part of this land was very rough, necessitating cuts and fills in leveling, which left many fields with a very nonuniform surface soil. The low swales and washes which have received the surface of the nearest ridges produce luxuriantly, while the higher places from which the surface soil has been removed always produce a poor growth until the soil is built up with manures and organic matter and silt in the irrigation water. This nonuniformity in an experimental plat is even more detrimental in effect than that occurring in an ordinary field. It is necessary to correct these soil variations within a plat in order that irrigation and culture may be uniformly applied.

It seems that even the most sandy of these soils contains enough silt and possesses a sufficient quantity of plant food to produce growth when the moisture content of the soil can be maintained. The water-holding capacity of this soil can be increased most economically by the addition of green manure. Alfalfa is altogether the best green-manure crop for this climate and soil. It not only adds humus through stem, leaf, and root decay, but deep in the soil below the cutting plane of the plow are left many roots, and it is in this subsoil that the addition of humus through any other method is practically impossible.

However, the production of some green-manure crop is often desirable where time does not permit the growing of an alfalfa crop. It has been found at the experiment farm that the Whippoorwill cowpea is very desirable as a summer green-manure crop. A plat of this crop planted in July, 1913, produced in 80 days, with the application of 2.33 acre-feet of water, 3.9 tons per acre of green plant material to be plowed into the soil. (See fig. 2.) This was the first crop grown on fine sandy land. It is likely that earlier planting would be more desirable. The cowpea will not endure frost and can not be used for a winter crop.

A selection of field peas[1] known as Golden Vine (S. P. I. No. 30134) withstood a minimum temperature of 16° F. during the winter of 1912–13 and promises to be a valuable winter-cover or green-manure crop.

FIG. 2.—Plowing under a crop of Whippoorwill cowpeas as green manure at the Yuma Experiment Farm. This crop produced approximately 3.9 tons per acre of green material in 80 days in 1913.

ALFALFA.

Alfalfa, which is the staple crop of the project, has generally produced good yields. In some parts of the project, however, yields have fallen much below the production of former years. In these districts it has been observed that the alfalfa fields 3 or 4 years old produced the smallest yields of hay. On various fields where a study of the soil was made it appeared that neither the presence of alkali nor the nearness of the ground-water plane was responsible for this retarded growth of the alfalfa plants. All the surface soils examined in this connection were typical of the valley. They were found to range from 14 to 34 inches in depth and were immediately underlain with a very open sand subsoil. The devel-

[1] The peas referred to are often designated as Canada field peas.

opment of the alfalfa root system at the surface of the subsoil suggests that the subsoil is unfavorable to the plants, as they tend to reroot in the surface soil instead of producing a deep taproot, which the alfalfa plant develops under normal conditions.

A record of these failing fields indicates that during the first and second seasons of growth good hay yields were secured. In the third and fourth seasons there were very noticeable decreases. This behavior may indicate that the growth of the first two seasons depends chiefly on the surface soil to depths of 14 to 34 inches, and at the end of that time, as the first surface roots have given way to the deeper ones, the plant is left with its taproot in the open subsoil, where moisture conditions are not sufficiently favorable to support luxuriant growth. This suggestion is supported by the root formation of plants in such soils. It seems that the alfalfa plants tend to reestablish surface roots in the upper soil to replace the deeper ones, and some plants are found with a well-developed surface root system. This condition is illustrated by figures 3 and 4.

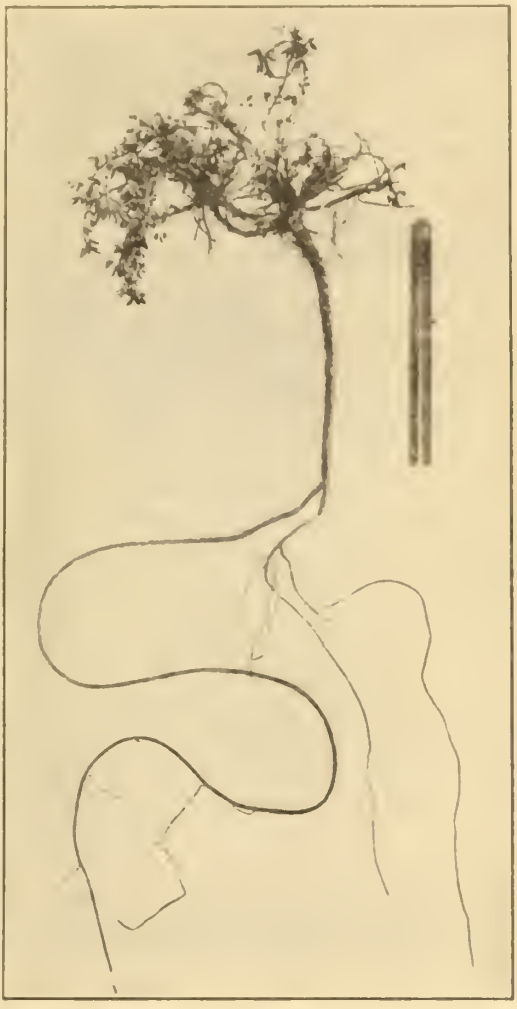

FIG. 3.—Alfalfa plant from uniform soil, showing normal root development. (Compare with figure 4.)

It seems that alfalfa culture in these shallow soils must be given special attention and treatment according to the depth of the surface soil. It may be necessary to plow under a crop of alfalfa every second or third year. In following such a method some cultivated crop should intervene for one season before reseeding to alfalfa. In this manner Bermuda grass or other weeds established in the alfalfa

fields may be eradicated. Cotton is probably the best cultivated crop to use for this purpose. The dense shade formed by the cotton plants, together with the cultivation given the crop, is very effective in eradicating Bermuda grass. Furthermore, cotton responds vigorously to the beneficial effects which the soil derives from the plowing under of alfalfa.

Alfalfa for seed is now the most important money crop of the Yuma project. The season of 1913 was very favorable to seed production. The average yields were good, while some exceptionally high yields were produced. Row-planting experiments at the experiment farm have not yet given sufficiently uniform results to determine the advisability of planting in this manner for seed production. Further plantings have been made to test this method by

FIG. 4.—Alfalfa plant from shallow surface soil and sand subsoil, showing abnormal root development. (Compare with figure 3.)

seeding rows from 4 to 28 inches apart. Fields producing seed at the experiment farm gave 40 per cent heavier yields when the second cutting was left for seed than when the third cutting was allowed to produce seed.

COTTON.

The importance of long-staple cotton production as an agricultural industry on the Yuma project is now generally recognized. Various cultural and breeding experiments were conducted at the experiment farm in 1913 in cooperation with the Office of Acclimatization and Adaptation of Crop Plants. Both Egyptian and Durango cotton were under trial, and several varieties and selections of Upland cotton were tested. With one exception, all commercial plantings of cotton produced on the Yuma project were of the Yuma variety of Egyptian

cotton. The farmers had varying success, according to the culture and attention given to the crop. Much cotton was planted too late to permit a maximum yield, while another common mistake was made in planting the seed too deep to secure uniform germination, which consequently necessitated replanting.

Several significant observations were made upon the production of cotton from soil containing high percentages of alkali salts, chiefly sulphates and chlorids. Cotton was grown well on certain fields where other crops had previously been killed by the presence of excessive amounts of these salts. In one case where determinations were made of the salt content it was found that cotton grew on a field containing more alkali in the surface 3 feet of soil than the adjacent field in which alfalfa seed had failed to grow.

Experiments in volunteering cotton have been continued. A plat of Egyptian cotton was volunteered through the past winter to a stand of 91 per cent. Different planting methods have been practiced to ascertain the effect of volunteering for the following season.

As during the preceding year, the 2-stand roller gin at the experiment farm was operated by the local farmers for ginning the 1913 Egyptian cotton crop.

GRAIN SORGHUM.

Experiments conducted with corn during the seasons of 1911 and 1912 and general observations of results obtained by farmers demonstrate that this crop is not adapted to the climatic conditions of the Yuma project. To supply the need of grain for working stock and also as a food for poultry, grain sorghums are known to be very valuable substitutes for corn in certain sections.

Seven varieties of grain sorghums were grown in 1913 in a combined variety and time-of-planting test. Each of these varieties was planted on the same date of each month from March to July, inclusive. The highest yield obtained with each variety, together with the planting dates which produced the best results with the different varieties in 1913, are shown in Table III.

TABLE III.—*Yields and dates of planting of the highest yielding plats of grain sorghums at the Yuma Experiment Farm in 1913.*

Variety.	Highest yielding plats.		Variety.	Highest yielding plats.	
	Yield per acre.	Planting date.		Yield per acre.	Planting date.
	Bushels.			*Bushels.*	
Feterita (Sudan durra)	73	Apr. 12	Blackhull kafir	30	June 18
Dwarf milo	41	May 20	Shallu	28	Apr. 12
Red kafir	37	Apr. 12	Dwarf Blackhull kafir	21	May 20
Brown kaoliang	31	June 18			

The only variety in this test excelling the commonly grown Dwarf milo was one known as feterita. As a plant where forage or silage is desired, the Red kafir seems to be the best of these seven varieties. It develops an abundance of broad leaves, which remain green until the head is mature. Red kafir also withstands the extremely high temperatures better than any other variety tried.

BROOM CORN.

A half-acre planting of broom corn was made in 1913 to ascertain the relative yields and behavior of the varieties commonly cultivated. Three varieties were planted on May 8. The yields of brush were as follows: Standard, 0.29 ton per acre; Dwarf, 0.23 ton per acre; and Dwarf Standard, 0.22 ton per acre. Owing perhaps to the spottedness of the soil, the maturity of the brooms was very irregular within each variety and the crop could not be harvested at one cutting.

HEMP.

Hemp was planted in rows at varying distances apart and spaced to varying distances within the row, to determine the possibility of and the best cultural methods for producing hemp seed. There being but one small planting of seed hemp in the community, much damage was done by birds, and the yields obtained were not dependable. Hemp plants grown in very close drill rows were examined for fiber, which proved to be of sufficiently good quality to compare favorably with the fiber of hemp produced in rainfall areas.

SUDAN GRASS AND TUNIS GRASS.

Sudan grass and Tunis grass, both recently introduced by the United States Department of Agriculture, were grown on the experiment farm during the season of 1913. In both cases seeding was made on May 14, which is perhaps about four weeks later than these crops should be planted. Tunis grass produced the best hay yields when grown in 3-foot rows and cultivated. On medium sandy-loam soil 4.2 tons of hay per acre were harvested in three cuttings. Sudan grass produced larger yields when seeded broadcast than when seeded in 3-foot rows. On light sandy-loam soil 8 tons of hay per acre were harvested in three cuttings. On heavier soils these grasses did not do so well.

WATER REQUIREMENTS.

During the season of 1913 approximate figures were obtained as to the quantity of water applied to the different field crops at the experiment farm. The method of measuring the water was not entirely satisfactory, but it is thought that the figures obtained are approximately correct. The results of the measurements are given in Table IV.

TABLE IV.—*Quantities of water applied to different crops on light soil and on medium soil at the Yuma Experiment Farm in 1913.*

Crop.	Water applied (acre-feet).		Crop.	Water applied (acre-feet).	
	Light soil.	Medium soil.		Light soil.	Medium soil.
Alfalfa	7.9	5.0	Broom corn	4.0	
Cotton	6.0	3.6	Hemp	5.9	
Grain sorghums	5.4	3.0	Cowpeas for green manure	2.3	1.5

It will be seen that almost twice as much water was used by the crops grown on the light soil as by those grown on the medium soil. These figures should not be considered as conclusive, as it will require further investigation to determine accurately the water requirements.

ORCHARD EXPERIMENTS.

DATES.

Seedling plants representative of nine promising varieties of dates are being grown in experimental orchards. A total of 737 plants were set to orchard positions during 1913. This makes a total planting of 1,687 seedling dates now included in the collection. In addition, 4,000 seedlings are growing in nursery rows.

The first flowering of seedling plants occurred in the spring of 1913. Of 459 trees planted in 1911, 26 produced flowers. The greater percentage of these were staminate trees, but it is frequently found that the staminate trees bear flowers at an earlier age than pistillate trees.

Despite a minimum temperature of 16° F. on January 6, 1913, it was found that 66 per cent of the seedling plants had received less than 50 per cent of leaf injury. The remaining 34 per cent were alive, but more than 50 per cent of their foliage was damaged. About 1,100 2-year-old seedling plants and 220 pounds of seed were distributed free of charge during the year to 41 farmers of the project.

FIGS.

The Smyrna Adriatic fig hybrids discussed in the report of this station for the year 1912[1] bore their first fruit during the summer of 1913. As stated in the report mentioned, the object of this experiment is to secure a strain of figs which will produce a desirable fruit of the quality of the Smyrna fig without the necessity of the presence of the small wasp (*Blastophaga psenes*) for pollinating the young fig, which the Smyrna variety requires and which it is difficult to carry through the winters in some localities where the fig can be grown.

[1] The work of the Yuma Experiment Farm in 1912. *In* U. S. Dept. of Agriculture, Bureau of Plant Industry Circular 126, pp. 17–25. 1913.

Of the 1,600 seedlings, 54 bore and matured fruits of good quality. There were 1,219 trees which did not flower, owing, perhaps, to injuries received from the freeze of the preceding winter; and 327 others set small figs, but the fruit was not matured and was shed for want of pollination. Some variation in frost resistance was noted among these seedlings. Observations of frost injury were made during the two winters of 1912–13 and 1913–14. The results are given in Table V.

TABLE V.—*Frost injury to fig seedlings during the winters of 1912–13 and 1913–14 at the Yuma Experiment Farm.*

Season.	Minimum temperature.		Uninjured.	Injured, growth killed being—	
	° F.	Date, 1913.		Less than half.	More than half, but not all.
			Per cent.	*Per cent.*	*Per cent.*
Winter of 1912–13	16	Jan. 6	55.4	2.7	41.9
Winter of 1913–14	21	Dec. 4	46.1	1.0	52.9

The injury received by these trees during the winter of 1913–14 was unusual. Water was withheld from the plantings early in the fall, but tender growth matured very slowly, owing to the excellent growing weather that continued until very late in the autumn.

DECIDUOUS FRUITS AND NUTS.

Commercial horticultural possibilities for Yuma Valley no doubt lie in specialized fruits, but every farmer should grow in his garden a few other fruits for home use. With the peculiar local conditions much is to be learned relative to adaptable varieties. With this in view, a variety test of deciduous fruits and nuts has been established. The following plantings were made in duplicate in 1913: 31 varieties of peaches, 16 of plums, 6 of prunes, 4 of apricots, 1 of nectarines, 1 of plumcots, 1 of cherries, 10 of pears, 6 of apples, 3 of quinces, 4 of almonds, 3 of walnuts, 3 of pecans, 10 of pistaches, 2 of jujubes, and 12 of persimmons. Several varieties of grapes and berries were also planted in a variety test.

In cooperation with the Office of Alkali and Drought Resistant Plant Investigations, about 200 pomegranate plants have been grown in orchard form since 1911. The pomegranate is well adapted to the local soil and climate, will bear heavy crops of fruit, and is useful in ornamental plantings. Its commercial possibilities are limited, but a few desirable fruiting plants will ordinarily be appreciated in any garden. The best of the named varieties fruiting at the experiment farm are "Sweet Fruited" and "Wonderful." In the collection of seedlings which are now beginning to bear fruit several promising types have been noted which are worthy of further testing.

VEGETABLES.

While garden crops can be grown to some extent throughout the year, most plantings are made during the late fall and early spring months. Two methods of culture are practiced in growing vegetables, the bed and the flat systems.

The cool-weather class of vegetables, such as cabbage, kohl-rabi, cauliflower, carrot, parsnip, turnip, beet, onion, lettuce, spinach, and pea, when planted in the fall succeed best on beds or ridges, being irrigated in the furrow and the water allowed to soak through but not to flood over the bed. The same vegetables planted in January, when they may be germinated without irrigation, grow well on the flat.

The class of summer vegetables, including peppers, eggplant, tomatoes, sweet potatoes, corn, beans, cucumbers, squashes, pumpkins, okra, and roselle, should be planted as soon as all danger of frost is over. With the exception of corn, they succeed best when planted in the bed or by the ridge method. By running water in the furrows before planting and then planting seeds or plants at the water line, they will receive sufficient moisture, leaving dry land for the plants and maturing fruit. Corn can best be grown when planted on the flat.

The ideal garden soil is a rich, warm, sandy loam, retentive of moisture but well drained. Sandy soil will be greatly benefited by liberal applications of rotted stable manure. Coarser organic material mixed with the heavier soils will improve their physical condition and prevent excessive baking and cracking, which are detrimental to small and delicate plants.

Most of the varieties recommended for the Yuma project by reliable seed houses have been planted at the experiment farm in comparable tests. Some valuable information as to desirable varieties and cultural methods has been secured from these tests. The following brief paragraphs give the names of the varieties which have produced the best results and make suggestions as to cultural methods:

Asparagus: Conover's Colossal and Giant Argenteuil. Asparagus plants are readily grown in this region. They thrive best in a rich sandy loam, but can be grown profitably in heavier soil or in sandy soil when well fertilized with stable manure. Slightly alkaline soil is favorable to asparagus. Root plantings should be made in furrows in the early spring, the furrow being filled gradually as cultivation progresses. The cutting of asparagus from established plantings begins in this climate about the middle of February.

Bean: Burpee's Stringless Green Pod and Tepary.—For string beans, Burpee's Stringless Green Pod and, for dry beans, Tepary are preferable. Most varieties of beans favorable to humid sections fail to yield desirable beans on the Yuma project owing perhaps to the extreme

temperature changes from day to night. Burpee's Stringless Green Pod is but one of many tested that produces good tender pods. It is an excellent variety for spring planting. The Tepary, or native desert bean of Arizona, is especially adapted to local culture under irrigation. It may be planted almost any time from April to August. The later crops ordinarily yield heaviest.

Beet: Early Model and Blood Turnip.—Many varieties of beets grow well, but perhaps these are most reliable.

Cabbage: Jersey Wakefield, Winningstadt, All Seasons, and Danish Ball Head.—Of the varieties of cabbage, the first two named are especially good for early planting. All Seasons is a large, late variety. The Danish Ball Head produces a round, solid head that holds up well.

Cantaloupe: Rocky Ford and Emerald Gem.—Of the varieties of muskmelons, the Rocky Ford is most popular. It yields heavily in these soils and needs no introduction in any market. For home use the Emerald Gem has great merit. While it does not yield so heavily as the Rocky Ford, it is earlier in ripening.

Carrot: Oxheart.—Carrots are readily grown both on the flat and by the bed system. For rapid growth and good roots free from woody tissue they should be irrigated frequently.

Casaba: Improved Hybrid and Bedwell's.—The casaba melon fruit is not widely known, but it has excellent quality and is rapidly coming into favor.

Cauliflower: Burpee's Best Early and Dry Weather.—Only early varieties of cauliflower do well. Seed sown in September should produce plants for transplanting by October. Cauliflower requires very rich soil and a great deal of water to produce good heads.

Corn.—No variety of sweet corn has yet been tested which yielded satisfactorily. The flowers of the plant appear to be "blasted" by the extreme heat. Five varieties of pop corn were planted during 1913, but no satisfactory yields were obtained.

Cucumber: White Spine.—Cucumbers should be planted in early spring on ridges 24 inches wide. Summer plantings are often attacked by the melon aphis.

Eggplant: Black Beauty.—The eggplant is very easily grown. The plants may be grown in a hotbed or seeded in the open. With frequent cultivations and sufficient moisture they will bear well through the hot summer.

Kohl-Rabi: White Vienna.—The kohl-rabi crop is cultivated the same as cabbage.

Lettuce: Prize Head and Wonderful.—All varieties of lettuce will grow here, but the Prize Head is especially recommended for a loose head, while the Wonderful produces an excellent solid head. For the best results, a rich soil and frequent irrigations are necessary.

Okra: White Velvet.—Okra seed should be planted in warm, moist soil, and the plants should be thinned to 24 inches in the row.

Onion: White Bermuda, Crystal Wax, and Australian Brown.—The White Bermuda and Crystal Wax onions have proved best for early sorts. The Australian Brown is later, has yielded well, and keeps the best of all varieties tried. Onions produce a good winter crop. They may be grown by either the flat or bed system.

Parsnip: Guernsey.—While parsnips can be grown, the quality does not equal those produced in colder climates. They may be grown in beds or on the flat.

Pea: American Wonder and Yorkshire Hero.—Both the varieties of peas named may be planted in the fall. The American Wonder often produces green peas in December. The Yorkshire Hero is a late variety producing large pods and yielding abundantly.

Peanut: Spanish and Valencia.—If planted in March, peanuts will mature in five or six months. They do best in a sandy-loam soil.

Pepper: Anaheim and Chinese Giant.—The Anaheim is largely grown for the market as a dried pepper. Peppers are easily grown, but they require frequent irrigation and cultivation.

Potato: Irish Cobbler, Triumph, and Early Ohio.—In a half-acre planting of six varieties of potato during the season of 1913, the varieties in the order mentioned above proved superior. The Irish Cobbler yielded far in excess of any other variety and should be planted more extensively on the project. The planting should be done between January 15 and February 1. The quality and earliness of the Irish Cobbler commend it as a worthy variety. Only the earliest varieties can be successfully produced.

Pumpkin: Large Cheese and Cushaw (or Crookneck).—The Large Cheese for feeding stock and the Cushaw for table use are the pumpkins best adapted for this locality. Seed should be planted on borders along previously irrigated furrows.

Radish: Early Scarlet Turnip and French Breakfast.—All of the small, quick-growing sorts of radish resembling the Scarlet Turnip have been grown successfully.

Spinach: Prickly-Seeded and Long-Standing.—These varieties should be grown during cool weather. Spinach requires sufficient water to keep it growing continuously.

Squash: Mammoth White Bush Scalloped.—The variety named is a good summer squash. The winter squashes do not do well here, as they frequently sunburn badly and do not keep well. Summer squash may be planted on ridges or on the flat.

Sweet Potato: White Vineless.—The variety named has proved superior to all sweet potatoes tested. They prefer sandy loam and succeed best when grown on ridges about 3½ feet apart, being irrigated in furrows.

Tomato: Dwarf Champion, Burpee's Quarter Century, and Dwarf Giant.—The dwarf types of tomatoes have generally proved best adapted.

Turnip: Purple Top Strap Leaf and Early White Milan.—Turnips of the varieties named can be grown during the winter either on borders or on the flat.

Watermelon: Chilean, Klondike, and Kleckley Sweets.—This region is preeminently the home of the watermelon. While all varieties do well, there is a vast difference in quality. The Kleckley Sweets is excellent for earliness and for home consumption. The Chilean and Klondike are worthy and popular varieties for market production.

FIG. 5.—Row of roselle plants in early flower at the Yuma Experiment Farm, 1913.

Roselle.—The roselle plant has long been cultivated in India for its fiber, but has been only recently introduced into this country. It is cultivated here for its edible, red, fleshy calyxes, which are used in making jellies and jams of rare quality. The roselle is an annual, propagated from seed and grown under cover. It is planted in the garden when all danger of frost is past, and is set in rows 6 to 10 feet apart, with the plants 6 to 8 feet apart in the row, depending on the quality of the soil. Early and late plantings seem to mature about the same time, usually about November 15, but the early plantings grow a larger plant and produce more flowers. A row of roselle plants is shown in figure 5.

ORNAMENTALS.

The mild winter temperatures of the Yuma project suggest the possibility of a great list of temperate and semitropical plants from which to choose in making ornamental plantings. Many plants that

are grown in parts of southern California will, no doubt, succeed, but numerous others will likely be found unadapted to the hot summers and dry air.

Palms have long been successfully grown in this region. The ornamental date palm (*Phoenix canariensis*) and the weeping fan palm (*Washingtonia filifera*) can not be excelled for individual or street plantings. Other sorts have also been planted.

The desirability of an evergreen tree in such a climate should be borne in mind in selecting varieties of trees for shade or street plantings. Quick growth is also desired in trees planted in a new country. Species of Eucalyptus combine both these qualities and supply wood of value, especially for posts and fuel. The plantings of 1-year-old seedlings of desert gum (*Eucalyptus rudis*) did not endure the minimum temperature of 16° F. during the winter of 1912–13 and were

FIG. 6.—One season's growth of bamboo on established roots at the Yuma Experiment Farm, 1913.

killed to the ground. A splendid growth came on through the next season and was not injured during the past winter when the minimum temperature was 24° F.

The most comfortably arranged desert house with screen-porch rooms should be well protected from the sun by climbing vines. Many annuals will furnish temporary shade, but plantings should be made of perennial evergreen climbers as a permanent improvement. It is not advisable to plant a vine of too dense growth, which will prevent free circulation of air, particularly on the south and southwest sides of the house. Probably no plants are better adapted for such plantings than climbing everblooming roses.

Many other vines, shrubs, and trees deserve a place in ornamental plantings when adaptable species and varieties are obtained. The grounds surrounding the buildings on the experiment farm are being planted with evergreen and deciduous plants. During the spring of

1913, 75 perennial plants were set out, representing 46 different species and varieties.

Bamboo plantings made in 1911 were killed to the ground by frost in January, 1913, but during the following season they made a luxuriant growth, as is shown in figure 6.

Approved:

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Chief of Bureau.

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